

Patent Claims

1. An illumination system for a microlithography projection exposure apparatus for illuminating an illumination field with the light from a primary light source, comprising:  
an optical axis (12, 112);  
a light distribution device (55, 155) for receiving light from the primary light source (11) and for generating a predeterminable, two-dimensional intensity distribution from the light from the primary light source in a first surface (25) of the illumination system;  
a first raster arrangement (35, 135) comprising first raster elements (36, 136) for receiving the spatial, two-dimensional intensity distribution and for generating a raster arrangement of secondary light sources;  
a second raster arrangement (40, 140) comprising second raster elements (41, 141) for receiving light from the secondary light sources and for at least partially superimposing light from the secondary light sources in the illumination field (51, 151);  
the light distribution device comprising at least one diffractive optical element (21, 121) for generating an angular distribution whose far field has separate or contiguous luminous zones (70, 72) which are coordinated in terms of form and size with the form and size of the first raster elements (36, 136) of the first raster arrangement.
2. The illumination system as claimed in claim 1, wherein the diffractive optical element (21, 121) is designed for setting a two-dimensional intensity distribution in the first surface (35) in such a way that all first raster elements (70, 72) associated with a predetermined exit light distribution are essentially completely illuminated by the intensity distribution,

while first raster elements which do not contribute to the exit light distribution remain essentially unilluminated.

5     3.    The illumination system as claimed in claim 1 or  
2, wherein the diffractive optical element (21, 121) is  
configured in such a way that the luminous zones (70,  
72) generate an approximately circular, approximately  
10   annular, or approximate dipole or multipole intensity  
distribution with a rastering corresponding to the form  
and size of the first raster elements on the raster  
elements (36, 136) of the first plane.

15   4.    The illumination system as claimed in one of the  
preceding claims, wherein no zoom device is arranged  
between the primary light source (11) and the first  
raster arrangement (35, 135).

20   5.    The illumination system as claimed in one of the  
preceding claims, wherein no axicon system is arranged  
between the primary light source (11) and the first  
raster arrangement (35, 135).

25   6.    The illumination system as claimed in one of the  
preceding claims, wherein no variably adjustable  
optical component is arranged between the primary light  
source (11) and the first raster arrangement (35, 135).

30   7.    The illumination system as claimed in one of the  
preceding claims, wherein the light distribution device  
comprises a changeover device (20) for exchanging a  
first diffractive optical element (21) for generating a  
first, two-dimensional intensity distribution for at  
least one second diffractive optical element (22) for  
35   generating a second, two-dimensional intensity  
distribution different from the first intensity  
distribution.

8. The illumination system as claimed in one of the preceding claims, wherein the diffractive optical element (21) has two or more differently structured partial regions which can optionally be introduced into the beam path of the illumination system for the purpose of generating a number of different, two-dimensional light distributions corresponding to the number of partial regions.

9. The illumination system as claimed in one of the preceding claims, wherein the diffractive optical element (21) is configured in such a way that at least one luminous zone (72) completely illuminates at least one raster element.

10. The illumination system as claimed in one of the preceding claims, wherein the diffractive optical element (21) is configured in such a way that at least one luminous zone (70) illuminates with maximum intensity at least one raster element apart from a narrow edge region (71).

11. The illumination system as claimed in one of the preceding claims, wherein the primary light source is a laser (11) having a divergence  $D_L$  in at least one plane containing the light propagation direction of the light, wherein a maximum divergence of the diffractive optical element in the plane is  $D_{Max}$ , and wherein the number  $n$  of the raster elements of the first raster arrangement, for generating a homogenizing effect, is predetermined such that a defined ratio (effective transmittance  $T$ ) of the proportion of radiation impinging on the first raster element (36, 136) with flat top intensity to the total radiation impinging on the first raster element (36, 136) is not undershot.

12. The illumination system as claimed in claim 11, wherein the effective transmittance  $T$  is greater than 70%, preferably greater than 80%.

13. The illumination system as claimed in one of the preceding claims, wherein the primary light source is a laser (11) having a divergence of between 0.5 and 1  
5 mrad in at least one plane containing the light propagation direction of the light, wherein the maximum divergence of the diffractive element (21, 121) in the plane is 30 mrad, and wherein the number of raster elements (36, 136) of the first raster arrangement (35,  
10 135) in the plane lies between 10 and 22.

14. The illumination system as claimed in one of the preceding claims, wherein the diffractive optical element (21, 121) is embodied as a computer-generated  
15 hologram.

15. The illumination system as claimed in one of the preceding claims, wherein the raster elements (36, 136, 41, 141) of the first and/or the second raster  
20 arrangement are embodied as microlenses.

16. The illumination system as claimed in one of the preceding claims, wherein a shading diaphragm (60, 160) for generating a sharp edge of the intensity  
25 distribution is provided in the vicinity of the illumination surface (50) or in the vicinity of a conjugate plane (70) with respect thereto.

17. The illumination system as claimed in one of the preceding claims, wherein at least one Fourier lens arrangement (23, 123) is arranged between the  
30 diffractive optical element (21, 121) and the first raster arrangement.

35 18. Method for producing semiconductor components and other finely structured devices, comprising the following steps:  
illuminating a reticle arranged in an object plane (70) of a projection objective with the light from a primary

light source (11) with the aid of an illumination system embodied as claimed in one of claims 1 to 17; generating an image of the reticle on a light-sensitive substrate;

5 wherein, for illuminating the reticle, the diffractive optical element (21, 121) generates a two-dimensional intensity distribution in the form of luminous zones (70, 72) on the first surface (25) of the illumination system, spatial distribution of which essentially  
10 corresponds to the form of a predeterminable exit light distribution.

19. The method as claimed in claim 18, wherein a changeover of illumination modes of the illumination  
15 system is carried out exclusively by exchanging the diffractive optical element (21, 121) and/or by optionally introducing differently structured partial regions of the diffractive optical element (21, 121) into the beam path of the illumination system.